NOVEMBER 2019

WIM #33
US 212, MP 78.5
OLIVIA, MN

MONTHLY
REPORT

Your Destination...Our Priority

WIM Site Location

WIM #33 is located on US 212 near Olivia in Renville county.

System Operation

WIM #33 was operational for the entire month of November 2019. Volume was computed using all monthly data.

System Calibration

WIM #33 was most recently calibrated on 2015-06-17. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 148982 | Passenger Vehicles: 119426 | Heavy Commercial Vehicles: 29556

Monthly Average Daily Traffic (MADT): 5013 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 985

 See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. EB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays. WB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Saturdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), EB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, WB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling EB typically reached peak volume levels between 03 PM and 05 PM, while volume going WB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 13's.

Overweight HCVs

Volume trends. Of a total of 29556 HCVs, 4925 of them were overweight [3]. These overweight HCVs contributed to 3.3% of total monthly volume, and 16.8% of total monthly

HCV volume. EB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Sundays. WB overweight vehicles tended to reach highest volumes on Sundays, with lowest volumes reported on Wednesdays. See Figure 3 .
The top two overweight violators by class were the class 13 and class 9 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 80% of all overweight vehicles traveling WB this month (see Figure 7 & 8).
Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in January.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,119 EB vehicles exceeded 88,000 pounds (77 vehicles were Class 13's; 21 vehicles were Class 9's). Of vehicles traveling WB,

933 EB vehicles exceeded 88,000 pounds (894 vehicles were Class 13's; 36 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from November 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in November 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling EB, while there were more empty Class 9's than fully_loaded traveling WB. Data also suggests that there were more empty Class 10's than fully_loaded traveling in the EB direction. In the WB direction, there were more empty class 10 vehicles.

Freight Totals. A total of 293812 tons of freight was recorded to have crossed the WIM. More freight was shipped WB (69.6%) than EB (30.4%). See Table 4 and Figure 11 for more freight information.

Infrastructure Considerations Bridge. Bridge No. 6299 (a box culvert) is approximately 13.4 miles east of WIM #33, and Bridge No. 96640 (a box culvert) is 2.5 miles west of WIM #33. WIM #33 recorded a total of 148982 vehicles with a combined GVW of 1949528 kips (1 kip = 1,000 pounds = 0.5 tons) in November 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 18799 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 57% of all ESALs were recorded WB while 43% was observed EB. In particular, 54% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 34% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

WIM monthly reports can be found at:
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle classification scheme and vehicle class groupings for traffic forecasting can be found at:
http://www.dot.state.mn.us/traffic/data/data-products.html#weight

- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)
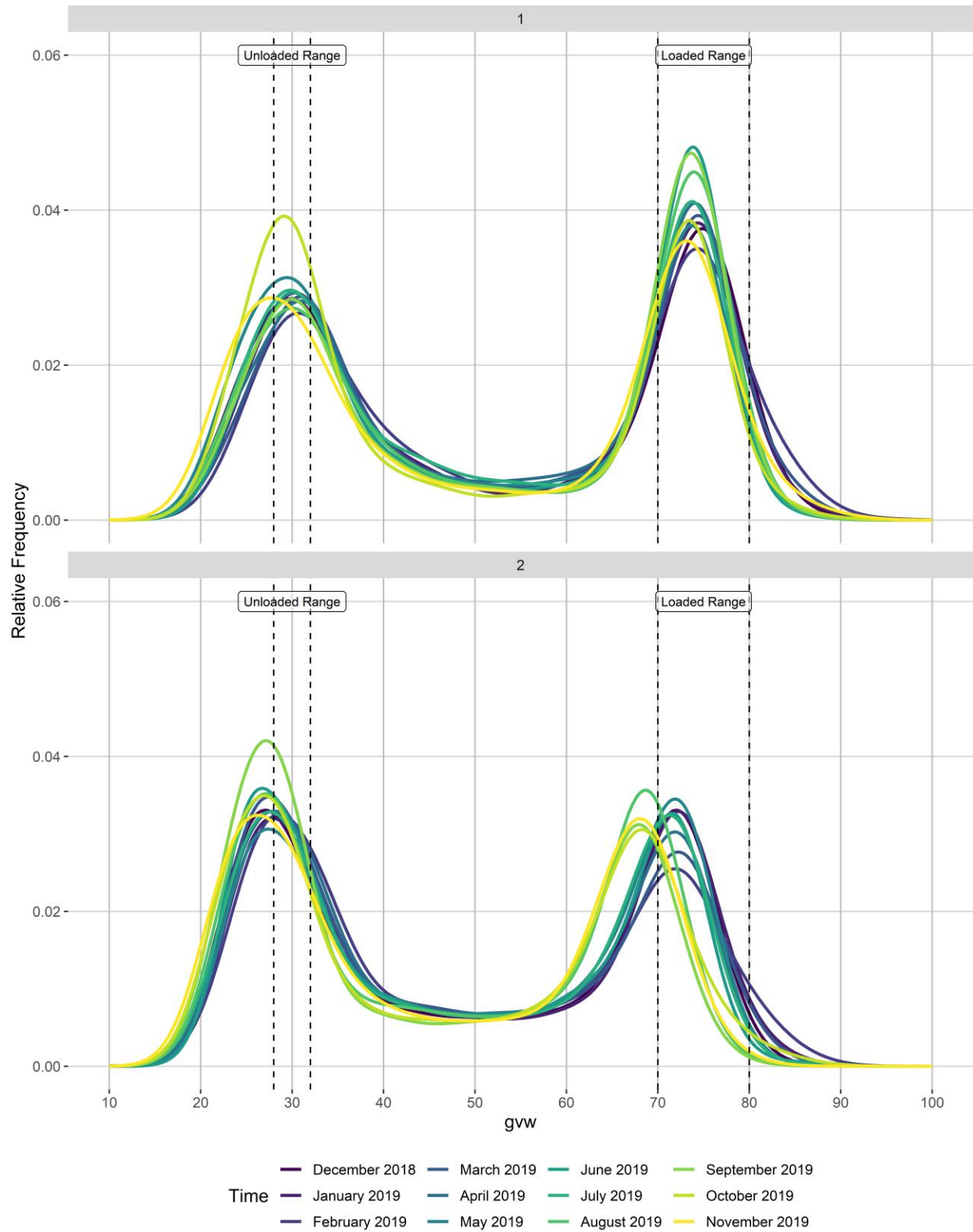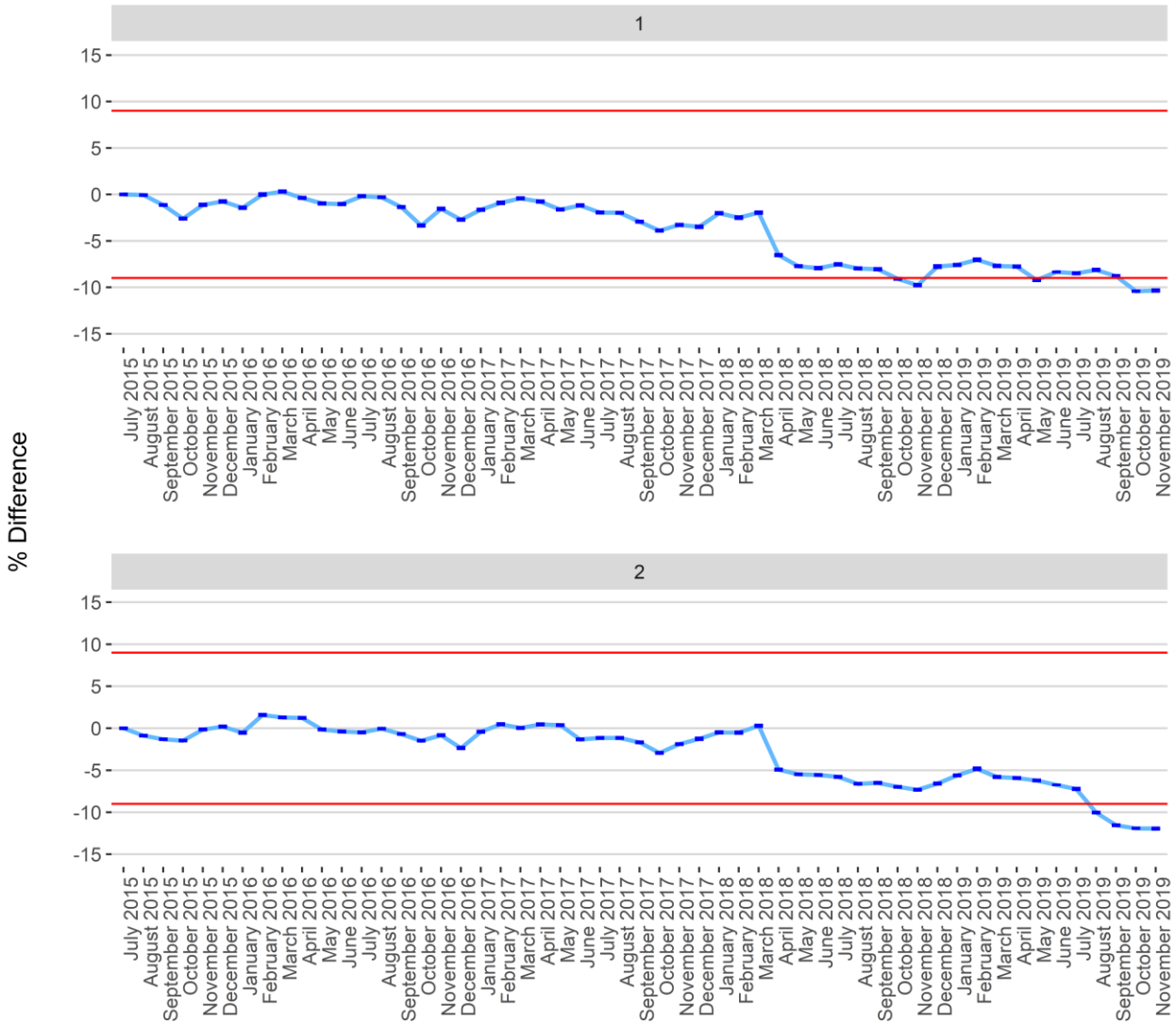
Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

Direction — EB — WB
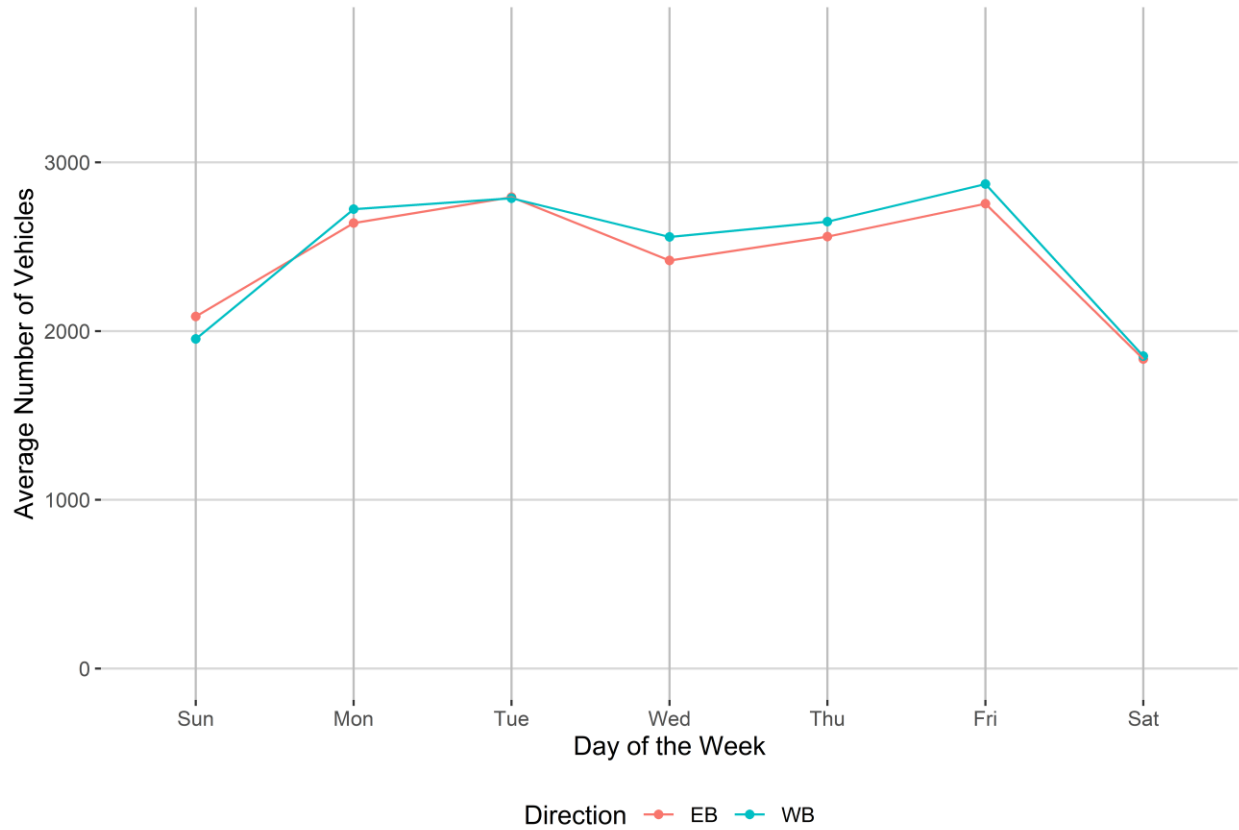
Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week
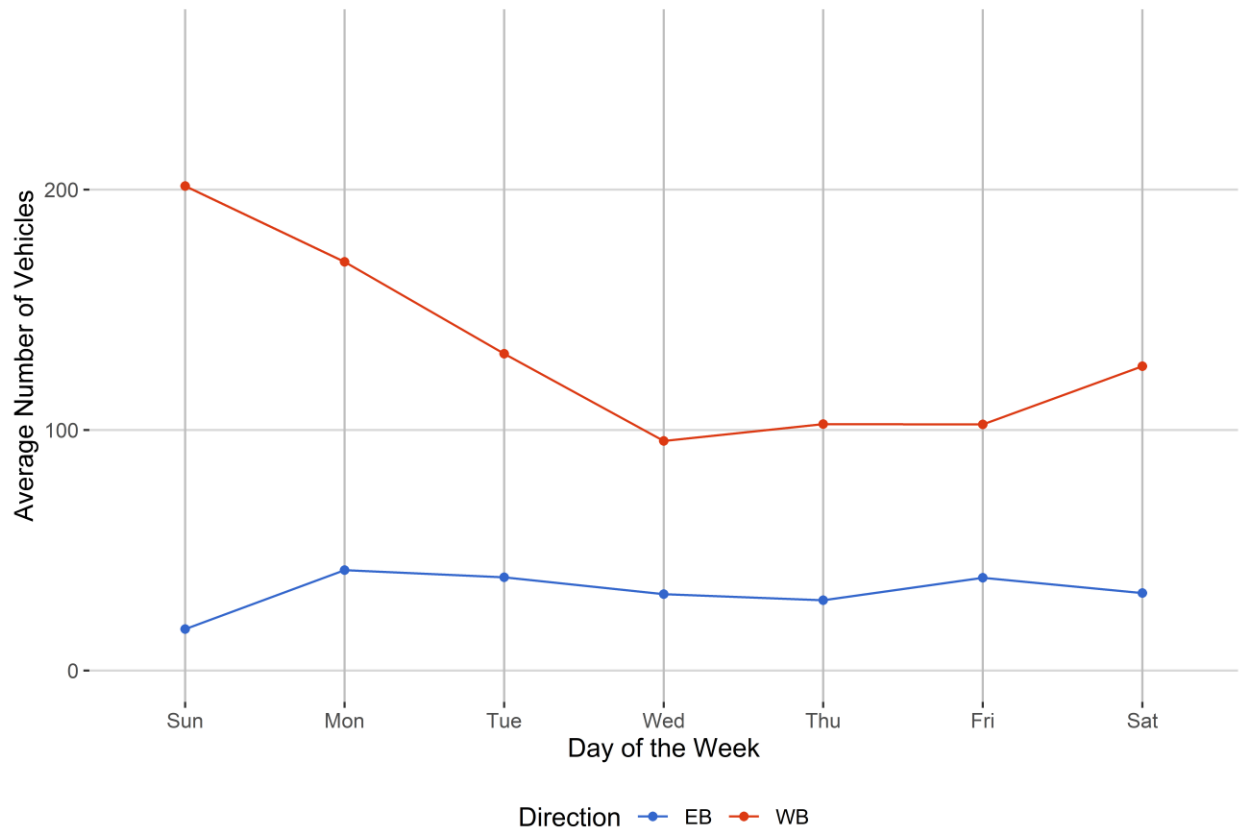
Direction — EB — WB

Figure 4 - Passenger Vehicles vs. Hour of the Day
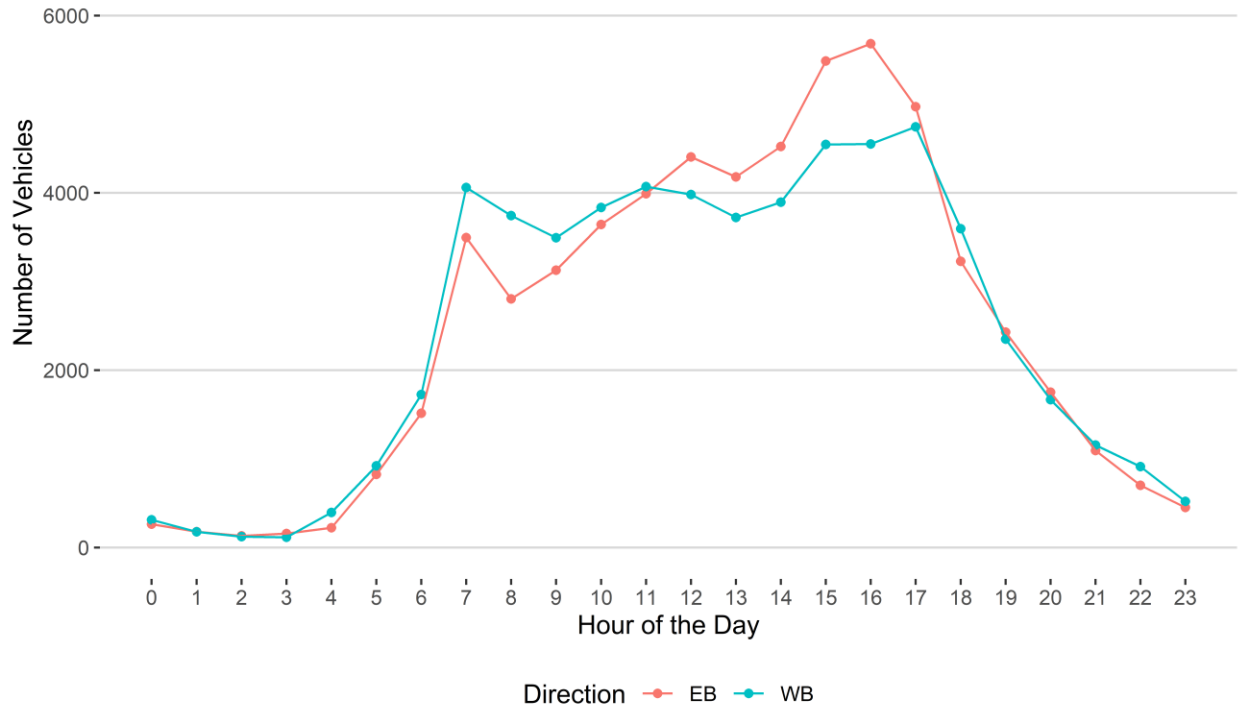
Direction — EB — WB

Figure 5 - Heavy Commercial Vehicles vs. Hour of the Day
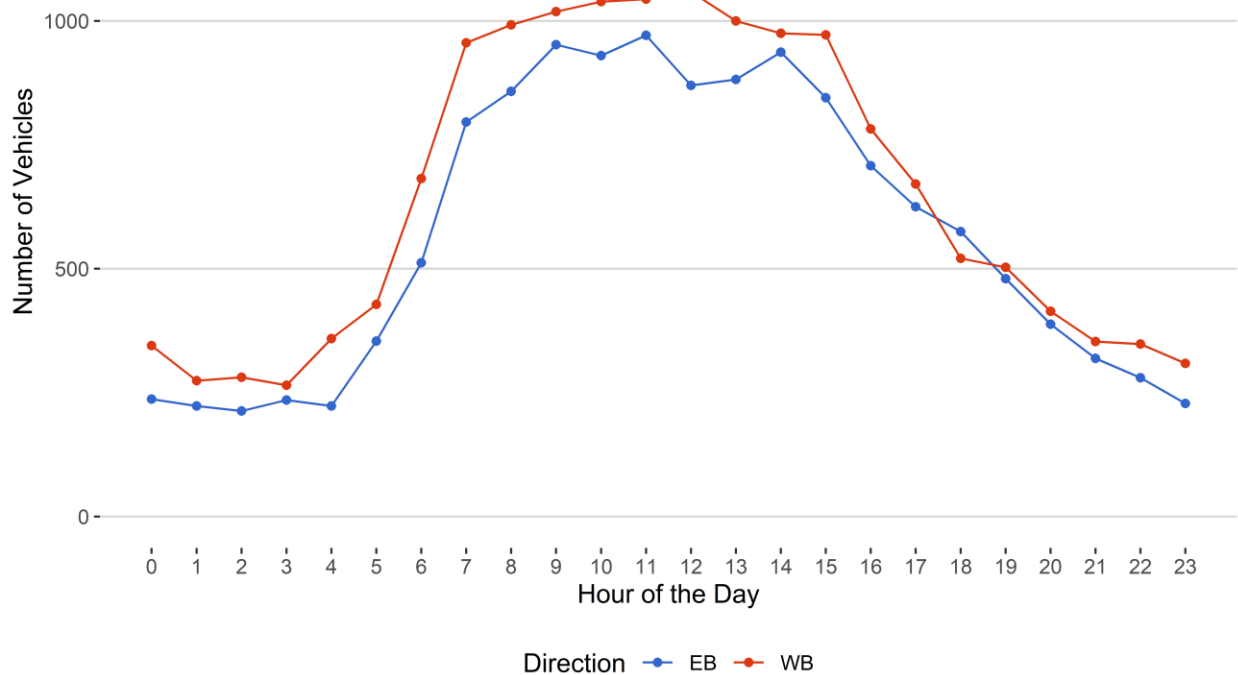
Direction — EB — WB

Figure 6 - Overweight Vehicles by Class vs. Hour of the Day
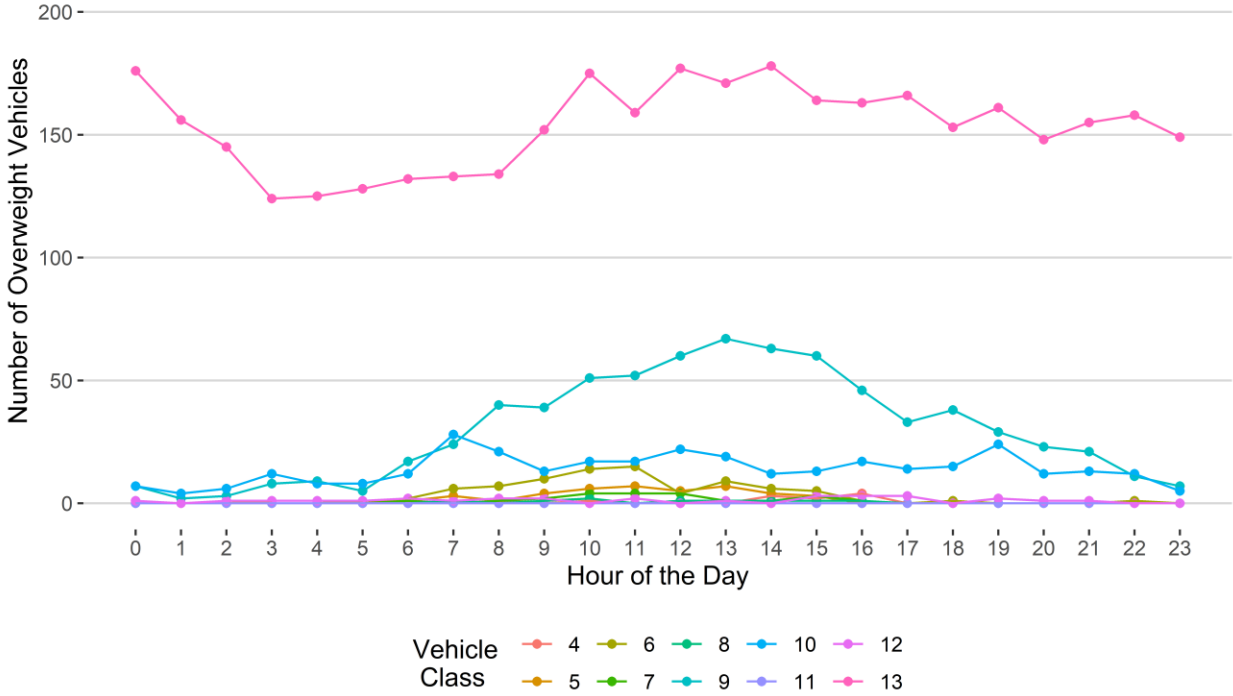
Figure 7 - Overweight Vehicles by Direction
 Hour of the Day
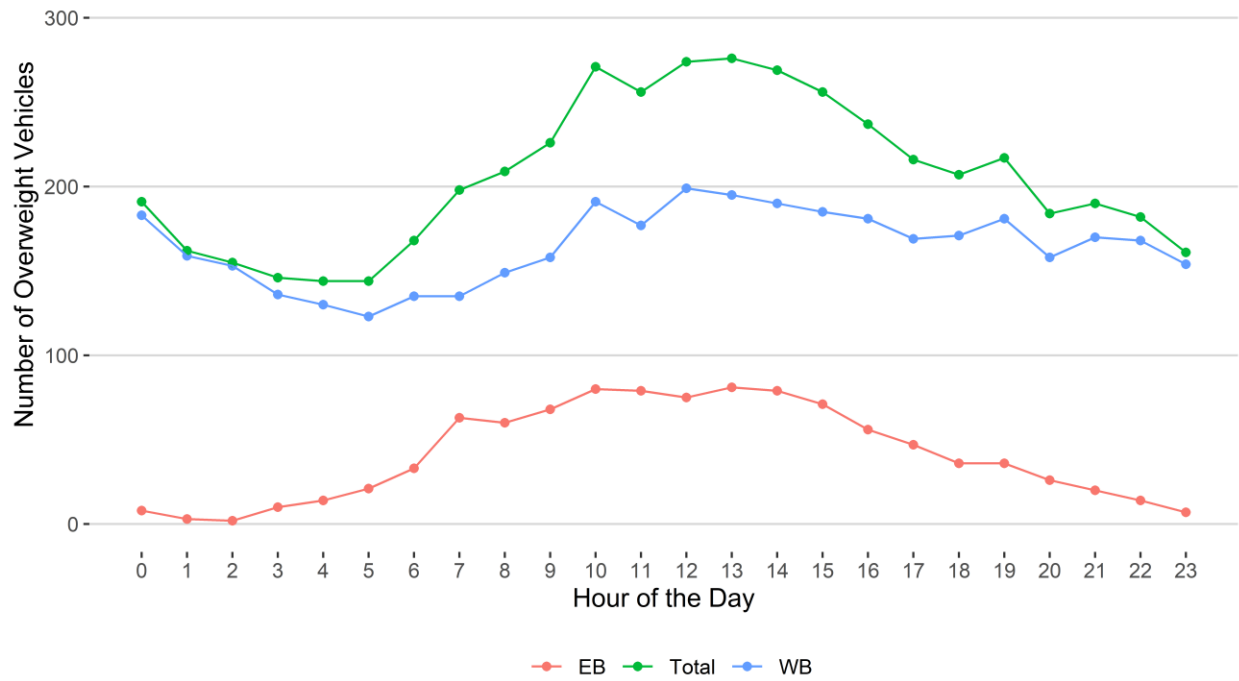
Figure 8 - Histogram of EB Vehicles Over 88,000 Pounds for Current Month
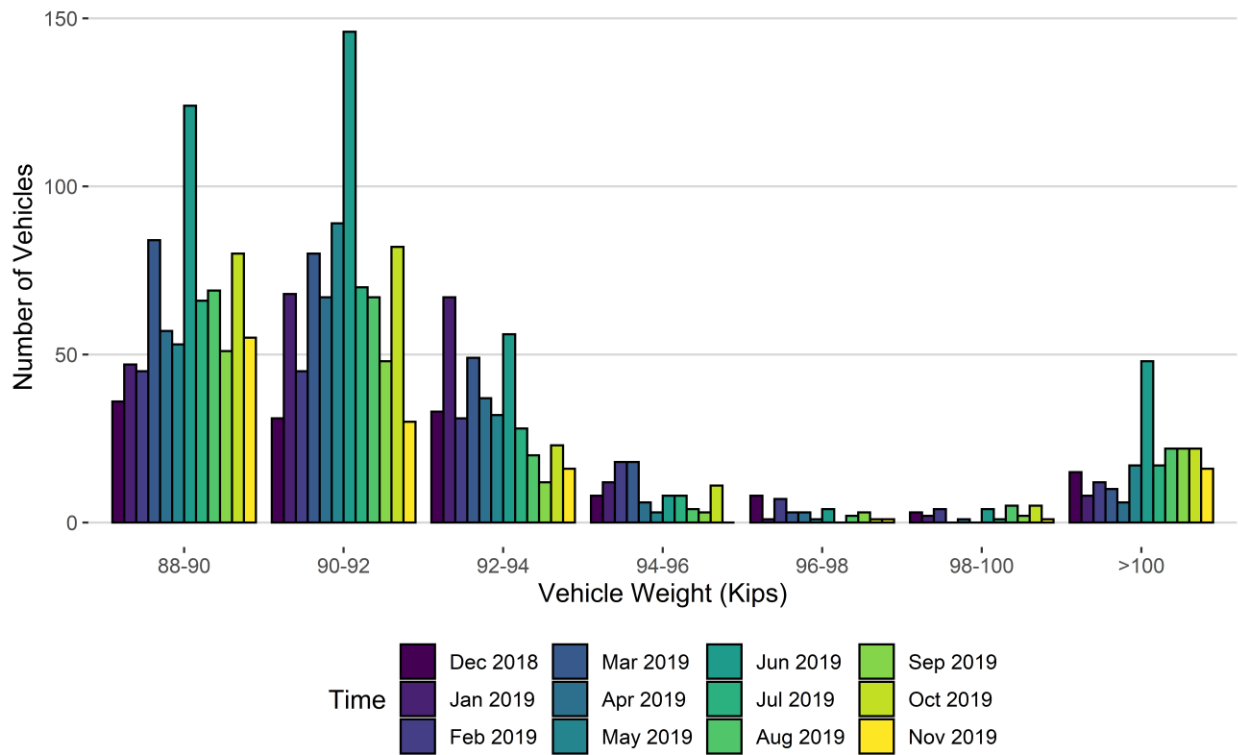
Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019
88-90	36	47	45	84	57	53	124	66	69	51	80	55
90-92	31	68	45	80	67	89	146	70	67	48	82	30
92-94	33	67	31	49	37	32	56	28	20	12	23	16
94-96	8	12	18	18	6	3	8	8	4	3	11	0
96-98	8	1	7	3	3	1	4	0	2	3	1	1
98-100	3	2	4	0	1	0	4	1	5	2	5	1
>100	15	8	12	10	6	17	48	17	22	22	22	16
Total	134	205	162	244	177	195	390	190	189	141	224	119

Figure 8 - Histogram of WB Vehicles Over 88,000 Pounds for Current Month
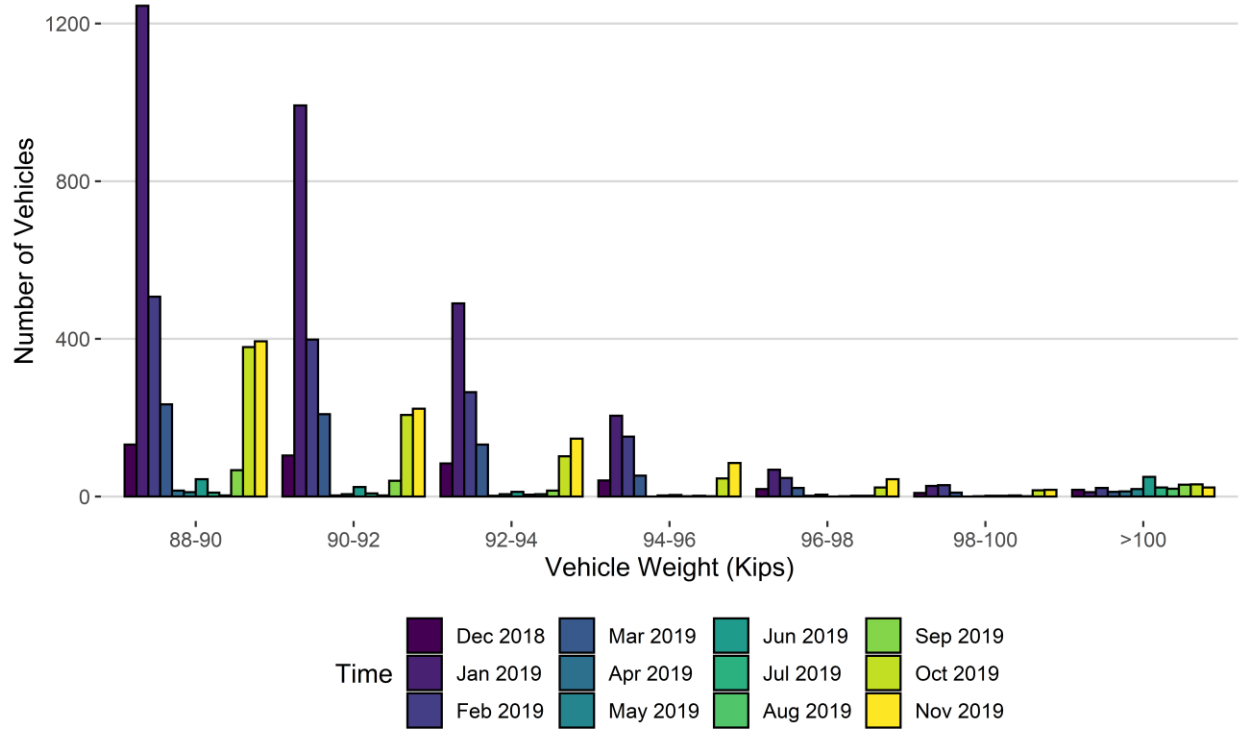
Vehicle Weights (Kips)	Dec 2018	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Jul 2019	Aug 2019	Sep 2019	Oct 2019	Nov 2019
88-90	132	1245	507	234	15	11	44	10	3	67	379	394
90-92	104	992	398	209	3	6	24	8	3	40	207	223
92-94	84	490	265	132	2	6	12	5	6	15	102	147
94-96	41	205	152	53	0	3	4	1	2	1	46	85
96-98	19	68	47	22	2	5	0	1	2	2	23	44
98-100	9	27	29	10	0	1	2	2	3	1	16	17
>100	17	11	22	12	13	19	50	23	20	30	31	23
Total	406	3038	1420	672	35	51	136	50	39	156	804	933

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

Figure 9 - Freight Percentage by Direction and Class

Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

Figure 11 - Total Gross Vehicle Weight k
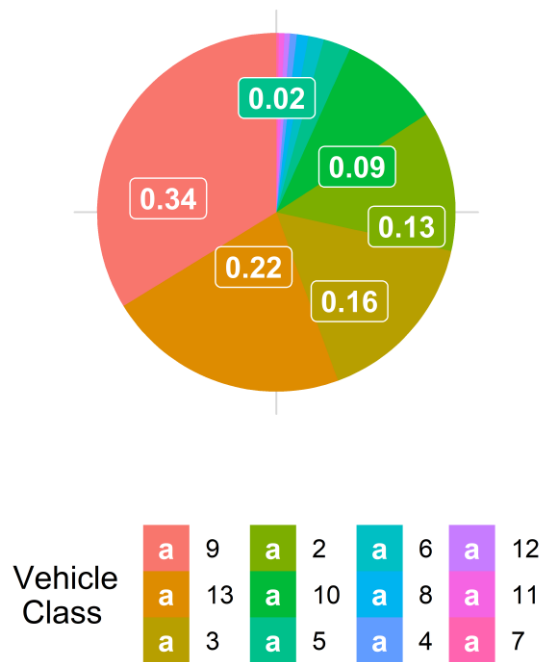
Figure 12 - Total ESALs by Class and Lane
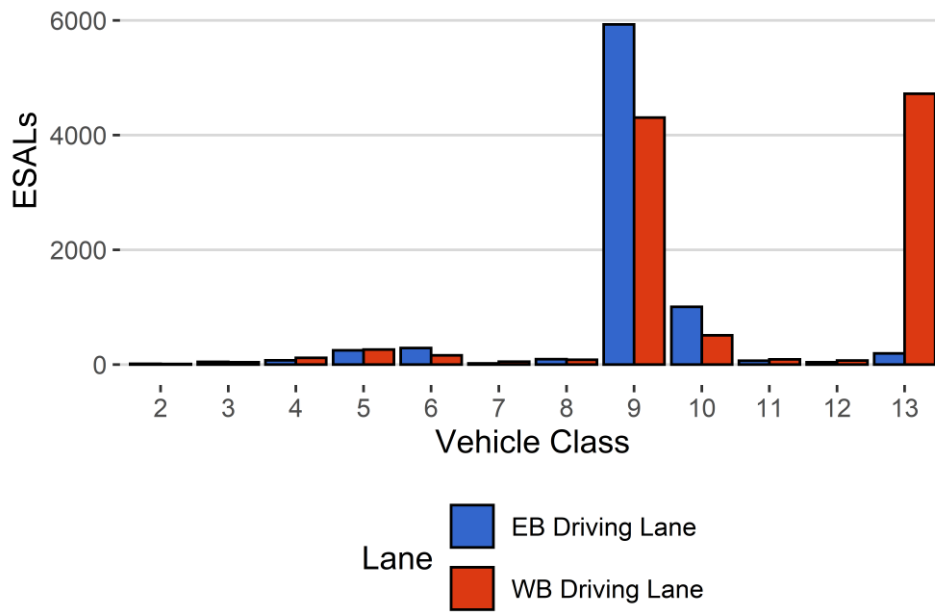
Figure 13 - ESALs by Class
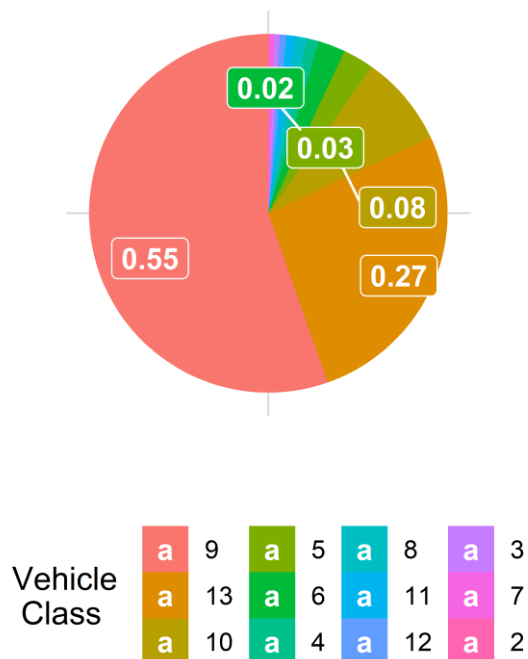
Table 1 Class 9 Front Axle Weight by Lane

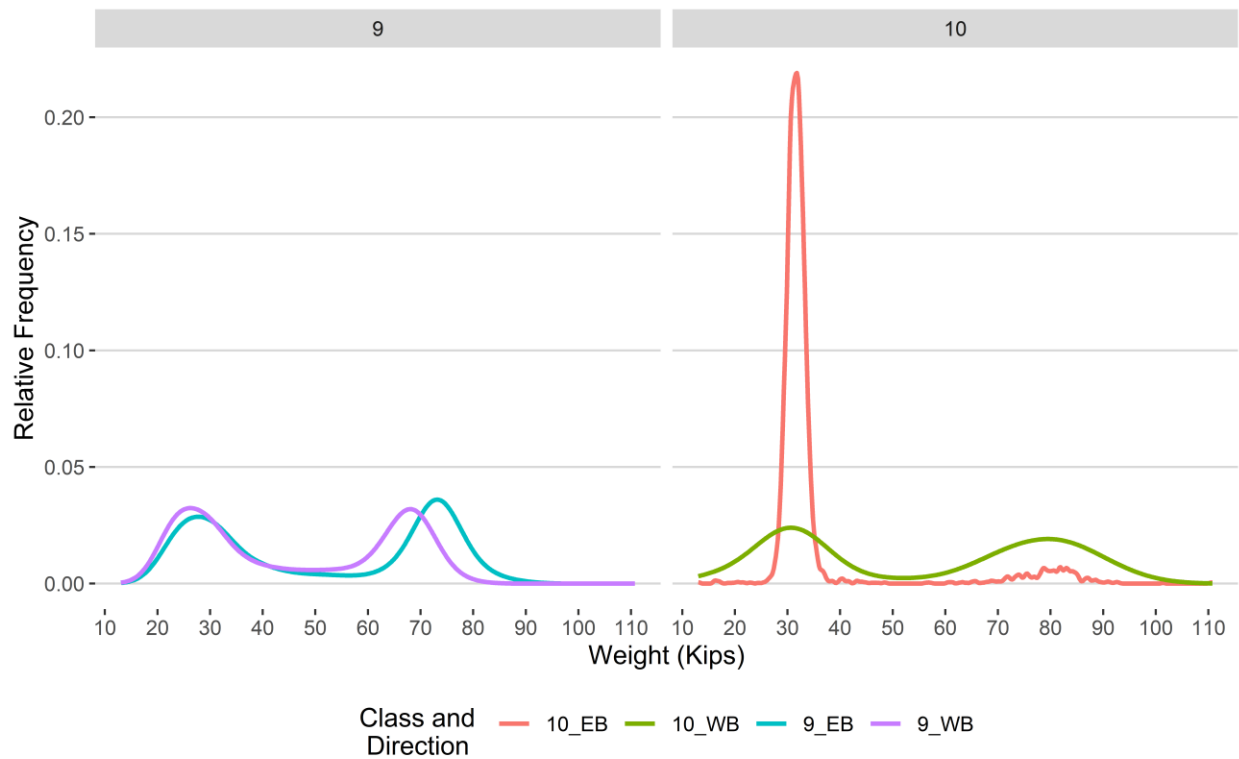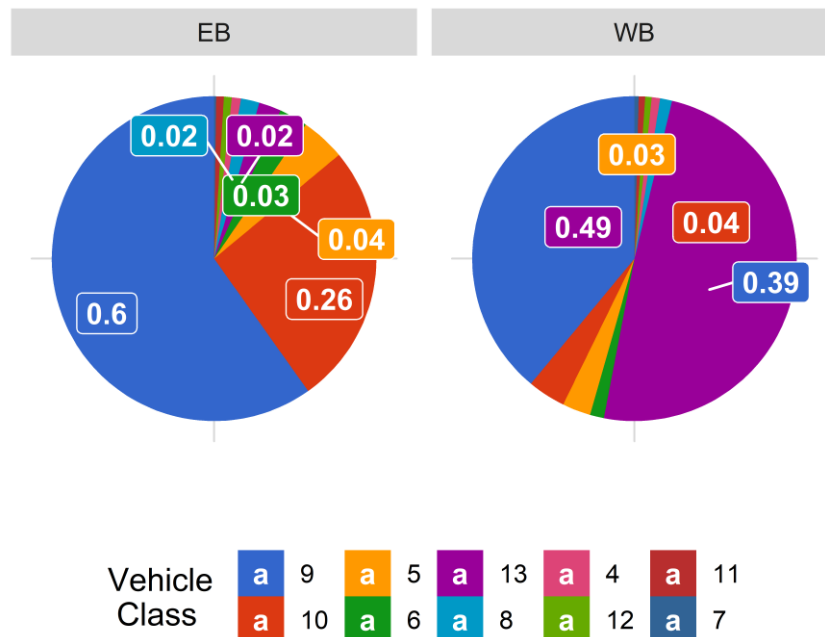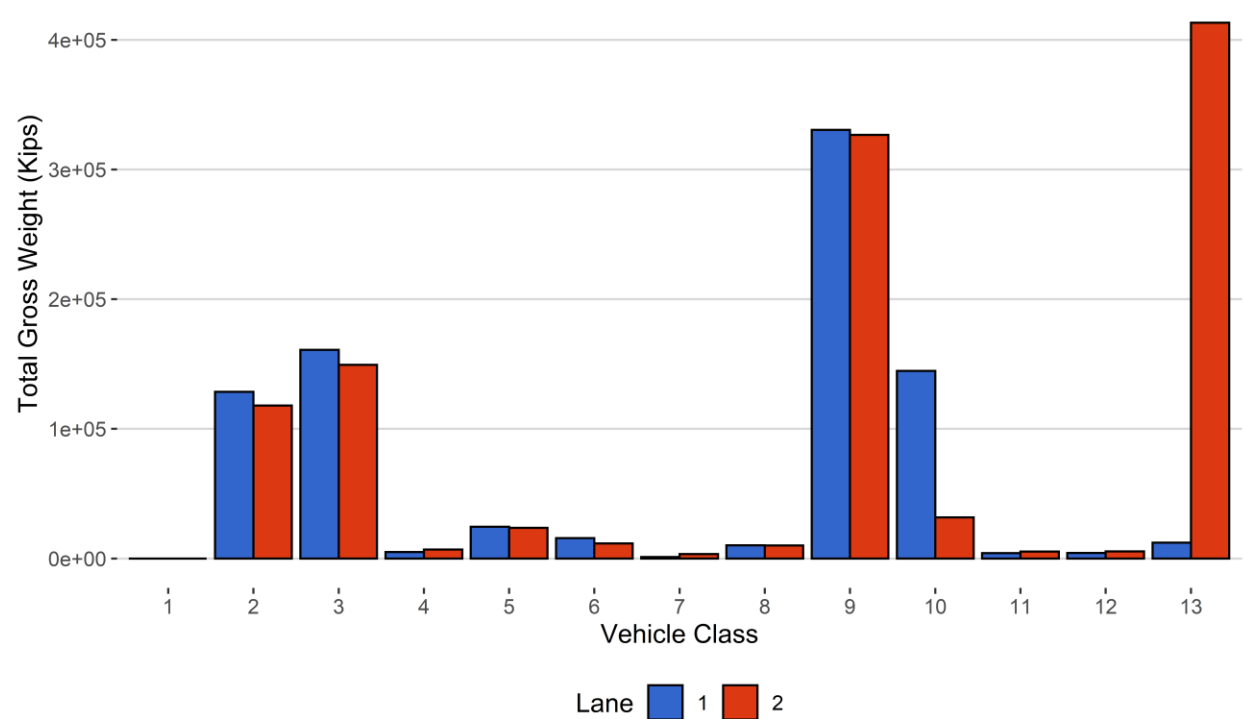| Month	Lane 1 (Kips)	Front Axle +/- 9%	Lane 2 (Kips)	Front Axle +/- 9%
July 2015	11.76	0.00	10.98	0.00
August 2015	11.75	-0.07	10.89	-0.88
September 2015	11.62	-1.13	10.84	-1.31
October 2015	11.45	-2.60	10.82	-1.46
November 2015	11.63	-1.12	10.97	-0.15
December 2015	11.67	-0.76	11.00	0.20
January 2016	11.59	-1.44	10.92	-0.53
February 2016	11.76	-0.01	11.16	1.58
March 2016	11.79	0.31	11.12	1.28
April 2016	11.71	-0.37	11.12	1.23
May 2016	11.64	-0.97	10.97	-0.15
June 2016	11.64	-1.04	10.94	-0.39
July 2016	11.74	-0.19	10.93	-0.49
August 2016	11.72	-0.31	10.98	-0.05
September 2016	11.60	-1.36	10.91	-0.69
October 2016	11.36	-3.35	10.82	-1.48
November 2016	11.58	-1.55	10.89	-0.83
December 2016	11.44	-2.72	10.72	-2.35
January 2017	11.56	-1.65	10.94	-0.41
February 2017	11.65	-0.91	11.03	0.47
March 2017	11.71	-0.43	10.99	0.03
April 2017	11.67	-0.77	11.03	0.46
May 2017	11.57	-1.63	11.02	0.37
June 2017	11.62	-1.18	10.84	-1.33
July 2017	11.53	-1.94	10.86	-1.15
August 2017	11.53	-1.98	10.86	-1.15
September 2017	11.41	-2.94	10.80	-1.68
October 2017	11.30	-3.90	10.66	-2.94
November 2017	11.37	-3.28	10.77	-1.89
December 2017	11.35	-3.49	10.84	-1.26
January 2018	11.52	-2.02	10.93	-0.49
February 2018	11.46	-2.50	10.93	-0.52
March 2018	11.53	-1.97	11.02	0.30
April 2018	10.99	-6.53	10.44	-4.92
May 2018	10.85	-7.73	10.38	-5.48
June 2018	10.82	-7.93	10.37	-5.55
July 2018	10.87	-7.53	10.35	-5.78
August 2018	10.82	-7.97	10.26	-6.62
September 2018	10.81	-8.05	10.27	-6.50

October 2018	10.69	-9.08	10.22	-6.98
November 2018	10.61	-9.77	10.18	-7.32
December 2018	10.84	-7.77	10.26	-6.58
January 2019	10.86	-7.59	10.37	-5.61
February 2019	10.93	-7.03	10.45	-4.83
March 2019	10.85	-7.70	10.35	-5.79
April 2019	10.84	-7.77	10.33	-5.92
May 2019	10.67	-9.22	10.30	-6.22
June 2019	10.78	-8.35	10.24	-6.74
July 2019	10.76	-8.49	10.19	-7.23
August 2019	10.80	-8.12	9.88	-10.04
September 2019	10.72	-8.79	9.71	-11.55
October 2019	10.53	-10.42	9.67	-11.91
November 2019	10.54	-10.34	9.67	-11.95

Table 2 Vehicle Classification Data

Vehicle Class	Monthly Average Daily Volume	Monthly Total Volume	Monthly Total Volume Percentage	Monthly Total Overweight Vehicles	Monthly Total Overweight Percentage
1	0	0	0	0	0
2	2136	64095	43	0	0
3	1844	55331	37.1	0	0
4	12	365	0.2	12	0.2
5	117	3523	2.4	44	0.9
6	33	982	0.7	82	1.7
7	3	94	0.1	22	0.4
8	24	732	0.5	9	0.2
9	454	13610	9.1	715	14.5
10	157	4710	3.2	331	6.7
11	6	194	0.1	0	0
12	6	176	0.1	28	0.6
13	172	5171	3.5	3682	74.8
TOTAL	**4966**	**148982**	**100**	**4925**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	Day of Week	Time	Vehicle Class	Direction	Lane	GVW (lbs)
2019-11-14	Thursday	07:18:09	10	EB	1	110.75
2019-11-15	Friday	07:16:14	10	EB	1	110.49
2019-11-01	Friday	15:15:11	10	EB	1	101.39
2019-11-05	Tuesday	22:44:40	10	WB	2	97.58
2019-11-29	Friday	23:19:04	10	WB	2	97.34
2019-11-04	Monday	08:25:05	10	WB	2	96.05
2019-11-18	Monday	04:46:39	10	WB	2	95.79
2019-11-30	Saturday	18:56:56	10	WB	2	95.76
2019-11-30	Saturday	20:26:11	10	WB	2	95.02
2019-11-17	Sunday	21:32:11	10	WB	2	94.83

Table 4 Freight Summary

Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	EB	15	158	20	12.7	4738	242	1334
5	EB	8	1740	240	13.8	22699	1738	5349
6	EB	19	536	112	20.9	13801	1897	2873
7	EB	11.5	21	0	0	1139	0	449
8	EB	31	357	239	66.9	4580	5622	461
9	EB	33	6410	2292	35.8	268553	62050	66330
10	EB	33.5	4086	3301	80.8	41817	102907	7760
11	EB	36.5	93	36	38.7	3015	1179	467
12	EB	36.5	87	9	10.3	4012	304	583
13	EB	31.5	153	12	7.8	11870	360	3714
TOTAL	****	****	**13641**	**6261**	****	**376224**	****	**89319**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	WB	15	203	23	11.3	6671	295	1985
5	WB	8	1744	329	18.9	21345	2332	5013
6	WB	19	435	131	30.1	9488	2110	1856
7	WB	11.5	72	0	0	3479	0	1325
8	WB	31	367	250	68.1	4229	5790	301
9	WB	33	7051	2871	40.7	251380	75348	56720
10	WB	33.5	572	226	39.5	25212	6446	6810
11	WB	36.5	99	1	1	5285	30	854
12	WB	36.5	87	1	1.1	5443	20	1152
13	WB	31.5	4961	0	0	413225	0	128477
TOTAL	****	****	**15591**	**3832**	****	**745756**	****	**204493**
GRAND TOTAL	****	****	**29232**	**10093**	**498**	**1121980**	**268669**	**293812**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	EB	WB	Total	Percentage
2	128563	117942	246504	12.7
3	160962	149373	310334	15.9
4	4981	6965	11946	0.6
5	24437	23677	48114	2.5
6	15698	11598	27295	1.4
7	1139	3479	4618	0.2
8	10202	10019	20221	1
9	330603	326728	657332	33.8
10	144724	31658	176382	9.1
11	4194	5314	9508	0.5
12	4316	5463	9779	0.5
13	12229	413225	425455	21.8
TOTAL	**842047**	**1105440**	**1947488**	**100**
GVW/LANE	**43.24**	**56.76**	**100**	**0.01**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	EB	WB	Total	Percentage	Flexible ESAL Factor
2	15	12	27	0.2	9e-04
3	50	42	91	0.5	0.0034
4	77	120	196	1.1	1.09
5	250	264	514	2.8	0.3
6	289	163	452	2.5	0.93
7	21	52	73	0.4	1.53
8	95	87	182	1	0.51
9	5928	4306	10234	55.4	1.52
10	1007	512	1519	8.2	0.65
11	68	92	160	0.9	1.64
12	41	71	111	0.6	1.27
13	197	4720	4918	26.6	1.93
TOTAL	**8039**	**10439**	**18478**	**100**	**11**
ESALS/LANE	**43.5**	**56.5**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	Total Volume	Monthly ADT	Monthly HCADT	Passenger Vehicles	Passenger Vehicles %	Heavy Commercial Vehicles	Heavy Commercial Vehicles %
Dec 2018	137277	4576	562	119844	87.3	17433.5	12.7
Jan 2019	136631	4407	857	110055	80.5	26575.5	19.5
Feb 2019	114260	4081	721	94070	82.3	20190.2	17.7
Mar 2019	138776	4477	648	118679	85.5	20096.7	14.5
Apr 2019	140330	4678	641	121113	86.3	19216.6	13.7
May 2019	162937	5174	679	141887	87.1	21050.5	12.9
Jun 2019	156866	5229	642	137597	87.7	19269.2	12.3
Jul 2019	159420	5102	597	140916	88.4	18504.3	11.6
Aug 2019	169242	5447	713	147124	86.9	22117.7	13.1
Sep 2019	152884	5138	780	129490	84.7	23393.9	15.3
Oct 2019	164055	5262	921	135502	82.6	28553.2	17.4
Nov 2019	148982	5013	985	119426	80.2	29556	19.8
TOTAL	**1781660**	–	–	**1515703**	–	**265957**	–
AVERAGE	**148472**	**4882**	**729**	**126309**	**85**	**22163**	**15**

ESALs

Month	ESALS EB Driving Lane	ESALS WB Driving Lane	Total ESALS	Pavement Life Decrease Months
Dec 2018	6326	6234	12560	2.5
Jan 2019	7551	12934	20486	3.3
Feb 2019	7266	8726	15992	3.6
Mar 2019	7505	7468	14973	2.2
Apr 2019	7081	5767	12848	0.6
May 2019	7030	6625	13655	0.7
Jun 2019	14609	11559	26168	1
Jul 2019	7391	4814	12205	1.8
Aug 2019	8503	6385	14889	2.2
Sep 2019	8209	6482	14690	0.9
Oct 2019	12116	14023	26139	1.7
Nov 2019	8078	10721	18799	1.8
TOTAL	**101666**	–	–	–
AVERAGE	**8472**	**8478**	**16950**	**2**

Gross Vehicle Weight

Month	GVW EB Driving Lane	GVW WB Driving Lane	Total GVW Kips
Dec 18	663511	704078	1367589
Jan 19	748717	1130601	1879318

Feb 19	624281	797364	1421645
Mar 19	705802	775079	1480881
Apr 19	705844	678545	1384390
May 19	771941	774947	1546888
Jun 19	1512692	1451859	2964551
Jul 19	779280	638532	1417812
Aug 19	836256	809778	1646034
Sep 19	806828	821209	1628037
Oct 19	1250632	1500920	2751552
Nov 19	843318	1106210	1949528
TOTAL	**10249104**	**11189123**	**21438227**
AVERAGE	**854092**	**932427**	**1786519**

Overweight Vehicles

Month	Total Number of Overweight Vehicles	Overweight / Total Volume	Overweight / Heavy Commercial Volume	Number Over 88,000 lbs	Number Over 98,000 lbs
Dec 2018	1711	1.2	9.6	540	44
Jan 2019	6767	5	25.7	3243	48
Feb 2019	4196	3.8	21.2	1582	67
Mar 2019	2644	1.9	13.3	916	32
Apr 2019	1066	0.8	5.6	213	20
May 2019	1059	0.7	5.1	246	37
Jun 2019	2304	0.7	6	528	106
Jul 2019	1055	0.7	5.9	240	43
Aug 2019	1367	0.8	6.2	229	51
Sep 2019	2137	1.4	9.2	297	55
Oct 2019	5352	2.3	13.2	1028	74
Nov 2019	4939	3.4	16.8	1052	57
TOTAL	**34597**	**–**	**–**	**10114**	**634**
AVERAGE	**2883.1**	**1.9**	**11.5**	**842.8**	**52.8**

Freight

Month	EB Freight Tons	WB Freight Tons	Total Freight	EB Freight %	WB Freight %
Dec 2018	71575	83742	155317	46.1	53.9
Jan 2019	81765	228122	309886	26.4	73.6
Feb 2019	80540	135572	216113	37.3	62.7
Mar 2019	86502	104160	190662	45.4	54.6
Apr 2019	86278	71227	157505	54.8	45.2
May 2019	85927	83228	169155	50.8	49.2

Jun 2019	176389	142159	318548	55.4	44.6
Jul 2019	89515	60126	149641	59.8	40.2
Aug 2019	100384	84516	184900	54.3	45.7
Sep 2019	98378	104905	203283	48.4	51.6
Oct 2019	141637	238961	380597	37.2	62.8
Nov 2019	89319	204493	293812	30.4	69.6
TOTAL	**1188209**	**1541211**	**2729419**	**–**	**–**
AVERAGE	**99017.4**	**128434.2**	**227451.6**	**45.5**	**54.5**